WHAT IS CLAIMED IS:

1. An image processing apparatus comprising:

a quantization component that quantizes input image data;

a calculation component that calculates a quantization error generated by quantization by said quantization component;

a buffer that stores the calculated quantization error;

an error diffusion component that diffuses the quantization error on the basis of at least a quantization error of a first pixel, which is stored in said buffer, and a quantization error of a second pixel, which is calculated by said calculation component; and

a reduction component that reduces the impact of an arithmetic error by said error diffusion component on a next input image data.

2. The apparatus according to claim 1, wherein said reduction component includes a connecting component that connects a decimal portion of a correction value generated by said error diffusion component to diffuse the quantization error to a lower bit side of the next input image data.

3. The apparatus according to claim 2, further

comprising a stop component that stops propagating the correction value in a case in which it is inappropriate to propagate the correction value to next and subsequent pixels.

4. The apparatus according to claim 2, further comprising:

a holding component that holds the decimal portion of the correction value; and

a clear component that clears the decimal portion held in said holding component in a case in which it is inappropriate to connect the decimal portion of the correction value, which is held in said holding component, to the lower bit side of the next input image data.

5. The apparatus according to claim 4, further comprising a processing limit component that limits clearing by said clear component when a scanning direction of the input image is reversed.

6. The apparatus according to claim 3, wherein the case in which it is inappropriate to propagate the correction value to next and subsequent pixels includes at least one of a case in which a pixel of interest is a start pixel of a line, a case in which the pixel of interest has a value equal to a lower limit level of

the input image, and a case in which the pixel of interest has a value equal to an upper limit level of the input image.

7. The apparatus according to claim 1, further comprising a numerical value limit component that limits the quantization error calculated by said calculation component to a numerical value within a predetermined range.

8. An image processing apparatus comprising:

a bit extension component that bit-extends image data of a pixel of interest;

a correction component that corrects the bit-extended image data;

a quantization component that quantizes an integral portion of the corrected image data;

a holding component that holds a quantization error generated by said quantization component;

a correction value generation component that generates a correction value to be used by said correction component on the basis of at least a first quantization error held in said holding component and a second quantization error related to the pixel of interest; and

a storage component that stores a decimal portion of the correction value, which is to be connected to a

lower bit side of next image data in bit extension processing by said bit extension component.

9. An image processing apparatus comprising:

a quantization component that quantizes a higher bit of input image data;

a calculation component that calculates a quantization error generated by quantization by said quantization component;

a buffer that stores the calculated quantization error;

an error diffusion component that executes error diffusion of image data of a third pixel on the basis of at least a quantization error of a first pixel, which is stored in said buffer, and a quantization error of a second pixel, which is calculated by said calculation component;

a holding component that holds a value not more than a predetermined bit of image data that has undergone error diffusion;

an addition component that adds an integral portion of the held value to the input image data; and

a bit connection component that connects a decimal portion of the held value to a lower bit side of the image data with the integral portion added and outputs the image data to said quantization component.

10. The apparatus according to claim 9, wherein said calculation component comprises a numerical value limit component that limits the calculated quantization error to a predetermined range and outputs the quantization error to said buffer.

11. The apparatus according to claim 9, wherein a maximum value of a quantization representative value to be used in calculating the quantization error is set to a value not less than a maximum value of the input image data.

12. The apparatus according to claim 11, wherein a step width of the quantization representative value to be used in calculating the quantization error is set to a constant value corresponding to a power of 2.

13. The apparatus according to claim 9, further comprising a stop component that stops propagating the held value in a case in which it is inappropriate to propagate the held value to next and subsequent pixels.

14. The apparatus according to claim 13, wherein the stop component comprises a clear component that clears the value held in said holding component in a case in which it is inappropriate to propagate the held value to next and subsequent pixels.

15. The apparatus according to claim 14, further comprising a processing limit component that limits clearing by said clear component when a scanning direction of the input image is reversed.

16. The apparatus according to claim 13, wherein the case in which it is inappropriate to propagate the held value to next and subsequent pixels includes at least one of a case in which a pixel of interest is a start pixel of a line, a case in which the pixel of interest has a value of a lower limit level of the input image, and a case in which the pixel of interest has a value of an upper limit level of the input image.

17. The apparatus according to claim 9, further comprising:

a first detection component that detects a pixel having a lower limit level value of the input image; and

a first code output component that, when the pixel having the lower limit level value of the input image is detected, outputs an output code that minimizes the quantization representative value as an output code related to the pixel.

18. The apparatus according to claim 9, further

comprising:

a second detection component that detects a pixel having an upper limit level value of the input image; and

a second code output component that, when the pixel having the upper limit level value of the input image is detected, outputs an output code that maximizes the quantization representative value as an output code related to the pixel.

19. The apparatus according to claim 9, further comprising a replacement component that, when a pixel having either a lower limit level value or an upper limit level value is detected, replaces the quantization error related to the pixel with 0.

20. A method for image processing comprising the steps of:

quantizing input image data;

calculating a quantization error generated in said quantization step;

storing the calculated quantization error in a buffer;

diffusing the quantization error on the basis of at least a quantization error of a first pixel, which is stored in said buffer, and a calculated quantization error of a second pixel; and

reducing the impact of an arithmetic error due to said error diffusion step on next input image data.

21. The method according to claim 20, wherein said reducing step includes a step for connecting a decimal portion of a correction value generated in said error diffusion step to diffuse the quantization error to a lower bit side of the next input image data.

22. The method according to claim 21, further comprising a step for stopping propagation of the correction value in a case in which it is inappropriate to propagate the correction value to next and subsequent pixels.

23. The method according to claim 21, further comprising the steps of:

holding the decimal portion of the correction value; and

clearing the decimal portion held in said holding step in a case in which it is inappropriate to connect the decimal portion of the correction value, which is held in said holding step, to the lower bit side of the next input image data.

24. The method according to claim 23, further comprising a step for limiting clear process of said

clear step when a scanning direction of the input image is reversed.

25. The method according to claim 22, wherein the case in which it is inappropriate to propagate the correction value to next and subsequent pixels includes at least one of a case in which a pixel of interest is a start pixel of a line, a case in which the pixel of interest has a value equal to a lower limit level of the input image, and a case in which the pixel of interest has a value equal to an upper limit level of the input image.

26. The method according to claim 20, further comprising a step for limiting the quantization error calculated in said calculation step to a numerical value within a predetermined range.

27. A method for image processing comprising the steps of:

bit-extending image data of a pixel of interest;

correcting the bit-extended image data;

quantizing an integral portion of the corrected image data;

holding a quantization error generated in said quantization step;

generating a correction value to be used in said

correction step on the basis of at least a first quantization error held in said holding step and a second quantization error related to the pixel of interest; and

storing a decimal portion of the correction value, which is to be connected to a lower bit side of next image data in bit extension process of said bit extension step.

28. A method for image processing comprising the steps of:

quantizing a higher bit of input image data;

calculating a quantization error generated in said quantization step;

storing the calculated quantization error in a buffer;

diffusing image data of a third pixel on the basis of at least a quantization error of a first pixel, which is stored in said buffer, and a calculated quantization error of a second pixel;

holding a value that is not more than a predetermined bit of image data that has undergone error diffusion;

adding an integral portion of the held value to the input image data; and

connecting a decimal portion of the held value to a lower bit side of the image data with the integral

portion added and outputting the image data.

29. The method according to claim 28, wherein said calculation step comprises a step for limiting the calculated quantization error to a predetermined range and outputs the quantization error to said buffer.

30. The method according to claim 28, wherein a maximum value of a quantization representative value to be used in calculating the quantization error is set to a value not less than a maximum value of the input image data.

31. The method according to claim 30, wherein a step width of the quantization representative value to be used in calculating the quantization error is set to a constant value corresponding to a power of 2.

32. The method according to claim 28, further comprising a step for stopping propagation of the held value in a case in which it is inappropriate to propagate the held value to next and subsequent pixels.

33. The method according to claim 32, wherein the stopping step comprises a step for clearing the value held in the case in which it is inappropriate to propagate the held value to next and subsequent pixels.

34. The method according to claim 33, further comprising a step for limiting clearing of said clearing step when a scanning direction of the input image is reversed.

35. The method according to claim 32, wherein the case in which it is inappropriate to propagate the held value to next and subsequent pixels includes at least one of a case in which a pixel of interest is a start pixel of a line, a case in which the pixel of interest has a value of a lower limit level of the input image, and a case in which the pixel of interest has a value of an upper limit level of the input image.

36. The method according to claim 28, further comprising the steps of:

detecting a pixel having a lower limit level value of the input image; and

outputting, when the pixel having the lower limit level value of the input image is detected, an output code that minimizes the quantization representative value as an output code related to the pixel.

37. The method according to claim 28, further comprising the steps of:

detecting a pixel having an upper limit level

value of the input image; and

outputting, when the pixel having the upper limit level value of the input image is detected, an output code that maximizes the quantization representative value as an output code related to the pixel.

38. The method according to claim 28, further comprising a step for replacing, when a pixel having either a lower limit level value or an upper limit level value is detected, the quantization error related to the pixel with 0.

39. A program of instructions executable by a computer to image process by performing the steps of:

quantizing input image data;

calculating a quantization error generated in said quantization step;

storing the calculated quantization error in a buffer;

diffusing the quantization error on the basis of at least a quantization error of a first pixel, which is stored in said buffer, and a calculated quantization error of a second pixel; and

reducing the impact of an arithmetic error by said error diffusion step on next input image data.

40. A program of instructions executable by a

computer to image process by performing the steps of:

bit-extending image data of a pixel of interest;

correcting the bit-extended image data;

quantizing an integral portion of the corrected image data;

holding a quantization error generated in said quantization step;

generating a correction value to be used in said correction step on the basis of at least a first quantization error held in said holding step and a second quantization error related to the pixel of interest; and

storing a decimal portion of the correction value, which is to be connected to a lower bit side of next image data in bit extension process of said bit extension step.

41. A program of instructions executable by a computer to image process by performing the steps of:

quantizing a higher bit of input image data;

calculating a quantization error generated in said quantization step;

storing the calculated quantization error;

diffusing image data of a third pixel on the basis of at least a quantization error of a first pixel, which is stored in said buffer, and a calculated quantization error of a second pixel;

holding a value not more than a predetermined bit of image data that has undergone error diffusion;

adding an integral portion of the held value to the input image data; and

connecting a decimal portion of the held value to a lower bit side of the image data with the integral portion added and outputs the image data.

42. The apparatus according to claim 9, further comprising

a component that detects that the quantization error of an immediately preceding pixel is 0; and

a change component that, when it is detected that the quantization error of the immediately preceding pixel is 0, changes an error diffusion coefficient related to the pixel.

43. The apparatus according to claim 42, wherein the change component changes the error diffusion coefficient to increase a ratio of a diffusion coefficient of a line on an upper side.

44. The apparatus according to claim 9, further comprising:

a component that calculates a difference between the input image data and a quantization representative value closest to the input image data; and

a change component that changes an error diffusion coefficient in accordance with the difference.

45. The apparatus according to claim 44, wherein the change component changes the error diffusion coefficient to increase a ratio of a diffusion coefficient of a line on an upper side as the difference becomes small.

46. The method according to claim 28, further comprising steps of:

detecting that the quantization error of an immediately preceding pixel is 0; and

when it is detected that the quantization error of the immediately preceding pixel is 0, changing an error diffusion coefficient related to the pixel.

47. The method according to claim 46, wherein in the change step, the error diffusion coefficient is changed to increase a ratio of a diffusion coefficient of a line on an upper side.

48. The method according to claim 28, further comprising steps of

calculating a difference between the input image data and a quantization representative value closest to

the input image data; and

changing an error diffusion coefficient in accordance with the difference.

49. The method according to claim 48, wherein in the change step, the error diffusion coefficient is changed to increase a ratio of a diffusion coefficient of a line on an upper side as the difference becomes small.

50. An image processing method of executing error diffusion processing for n-valued image data to convert the n-valued image data into m-valued image data ($2 \leqq m < n$) to form a pseudo halftone image, comprising the steps of:

inputting the n-valued image data;

adding a quantization error accumulated by preceding error diffusion to the input n-valued image data;

generating noise;

determining a sign of the noise;

adding the noise with the determined sign to the n-valued image data with the quantization error added;

converting the n-valued image data with the noise added into m-valued image data;

inversely quantizing the m-valued data into a quantization representative value;

subtracting the quantization repr sentative value

obtained in the inverse quantization step from the n-valued image data with the added quantization error to generate a quantization error; and

storing the generated quantization error in a buffer.

51. The method according to claim 50, wherein the quantization error addition step includes the step of adding a quantization error accumulated by distributing the quantization error stored in the buffer to a plurality of pixels using a predetermined distribution coefficient.

52. The method according to claim 50, wherein the determination step includes the step of determining the sign of the noise on the basis of a value of a specific bit of the input n-valued image data.

53. The method according to claim 50, wherein the generation step includes the step of generating the noise by selecting a value corresponding to the number of bits of the noise from a shift register output of an M-sequence pseudo random code generation circuit which uses a shift register more than the number of bits of the noise to be generated.

54. The method according to claim 52, further

comprising a limit step of limiting a value of the noise generated in the generation step to not more than a predetermined value.

55. The method according to claim 54, wherein in the limit step, when the specific bit is 1, the smaller of either a value represented by bits on a lower order than the specific bit of the input n-valued image data or a first predetermined value is set as the predetermined value, and when the specific bit is 0, the smaller of either a value represented by bits obtained by inverting the bits on the lower order than the specific bit of the input n-valued image data or the first predetermined value is set as the predetermined value.

56. The method according to claim 55, wherein the value limited in the limit step is not more than a second predetermined value, the second predetermined value being set as the predetermined value.

57. The method according to claim 54, wherein a limiter executes limiting in the limit step.

58. The method according to claim 54, wherein a gain adjuster executes limiting in the limit step.

59. An image processing apparatus for executing error diffusion processing for n-valued image data to convert the n-valued image data into m-valued image data ($2 \leqq m < n$) to form a pseudo halftone image, the apparatus comprising:

an input component that inputs the n-valued image data;

a first addition component that adds a quantization error accumulated by preceding error diffusion to the n-valued image data input by said input component;

a generation component that generates noise;

a determination component that determines a sign of the noise;

a second addition component that adds the noise with the sign determined by said determination component to the n-valued image data with the quantization error added by said first addition component;

a quantization component that converts the n-valued image data with the noise added by said second addition component into m-valued image data;

an inverse quantization component that inversely quantizes the m-valued data obtained by said quantization component into a quantization representative value;

a quantization error generation component that

subtracts the quantization representative value obtained by said inverse quantization component from the n-valued image data with the quantization error added by said first addition component to generate a quantization error; and

a buffer that stores the quantization error generated by said quantization error generation component.

60. A program that executes the steps of the image processing method of claim 50.

61. A storage medium storing computer-readable code for causing a computer to execute the program of claim 60.